



Master on Industrial Electronics and Computers Engineering
Specialization on Control, Automation and Robotics

Autonomous Intelligent Systems 2023/2024:

Project 2 Middle Evaluation

16/04/2024

Group 4: RIMA Robotics

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Agenda:



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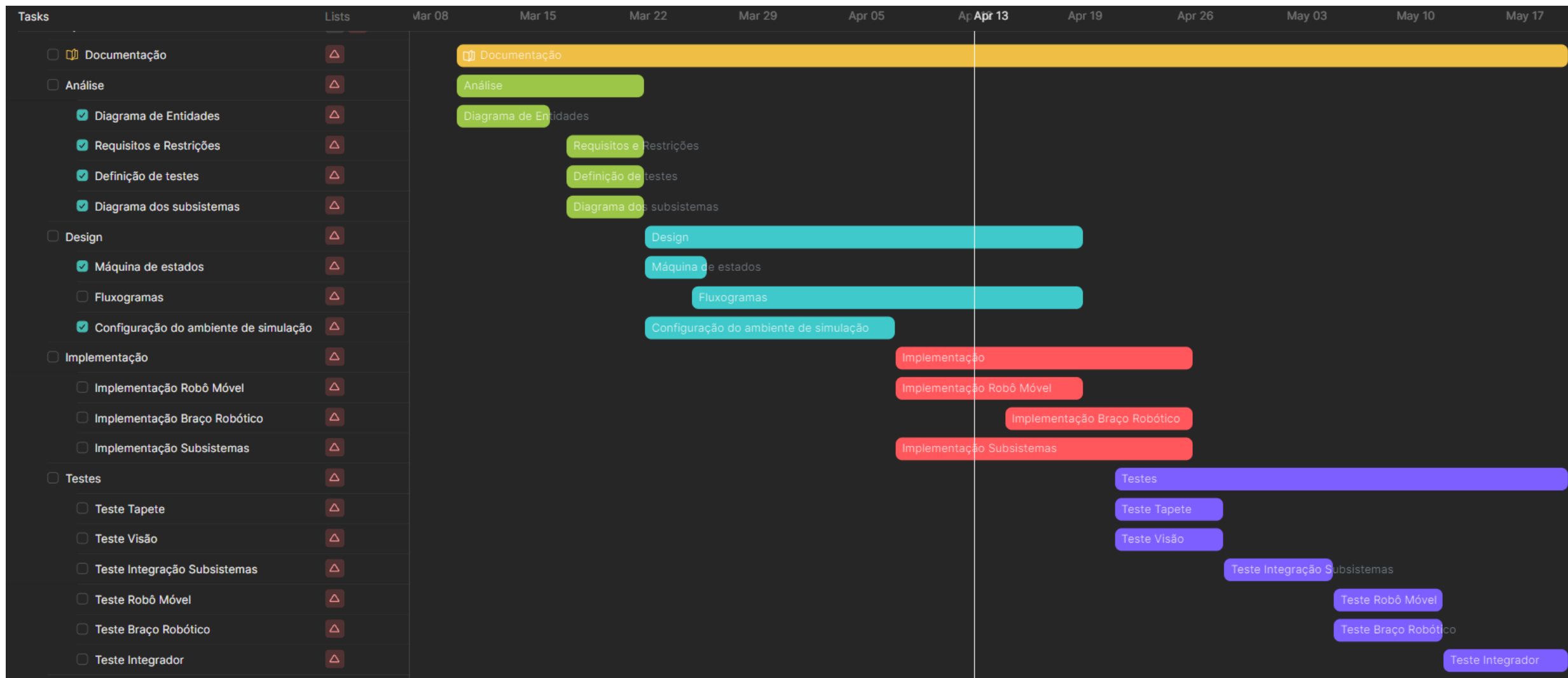
- **Timetable;**
- **Requirements and Constraints;**
- **System Overview Diagram;**
- **Subsystem Diagram**
 - **Mobile Robot;**
 - **Robotic Arm;**
 - **ConveyorIn;**
 - **Parking System;**
- **State Machine Simplified;**
- **State Machine Detailed;**
- **Tests**
 - **Conveyor;**
 - **Mobile Robot;**
 - **Robotic Arm;**
- **Next Steps;**



Timetable:



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Requirements and Constraints:

Requirements:

1. Functional

- Development of an autonomous movement algorithm for a mobile robot;
- Development of a control algorithm for a robotic arm;
- Object detection system;
- Obstacle detection system;
- Integration of subsystems for the pick-and-place;

2. Non-Functional

- Movement optimization;
- Precision when grabbing/landing objects;
- Intuitive movements;

Restrictions:

1. Technical

- Use of the Coppelia simulation platform;
- Grasping only one box at a time;
- Utilization of Matlab as the programming language;
- Utilization of the mobile robot KUKA;
- Utilization of the robotic arm LBR iisy (6 DOF), UR10e (6 DOF), KUKA LBR iiwa (7 DOF);

2. Non-Technical

- Project design deadline until May 24, 2024;;
- Group of 4 members;



Tests:



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Conveyor Test:

- Conveyor control for sending and receiving boxes;
- Sensor system to assess the presence and identification of the box ;

Mobile Robot Test

- Autonomously control omnidirectional movement of the robot;
- Obstacle avoidance;
- Stop for unloading and picking up objects;

Simulation Objects Test:

- Determine the behavior of the boxes with the other systems;
- Definition of the appearance of the boxes on the carpet;
- Definition of the disappearance of the boxes on the shelf;

Robotic Arm Test

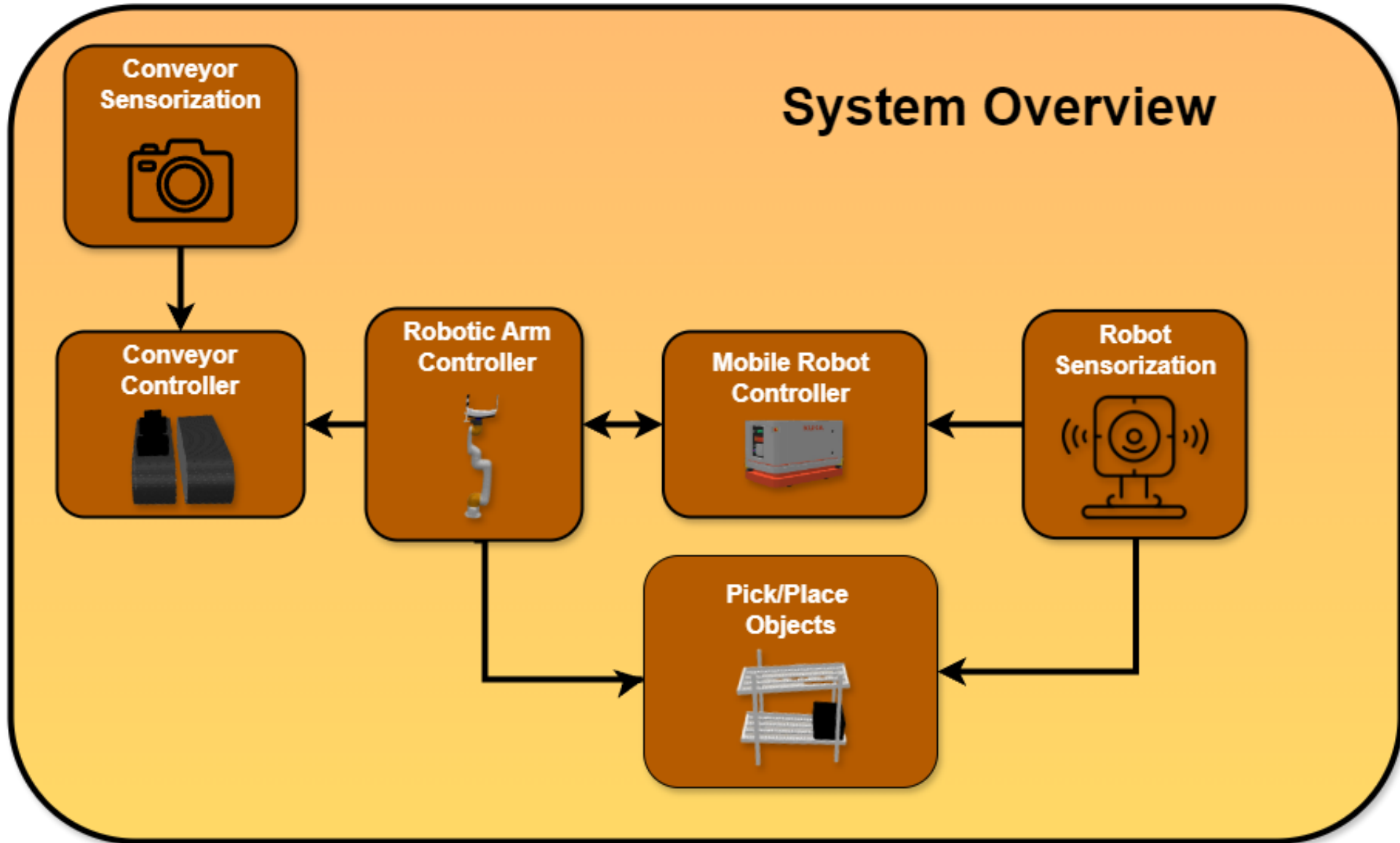
- Definition of the movement to pick up a box from the carpet and deliver it to the shelf;
- Definition of the movement to pick up a box from the shelf and deliver it to the carpet;
- Arm position for transportation;
- Define motion settings;
- Define resting position;



System Overview:



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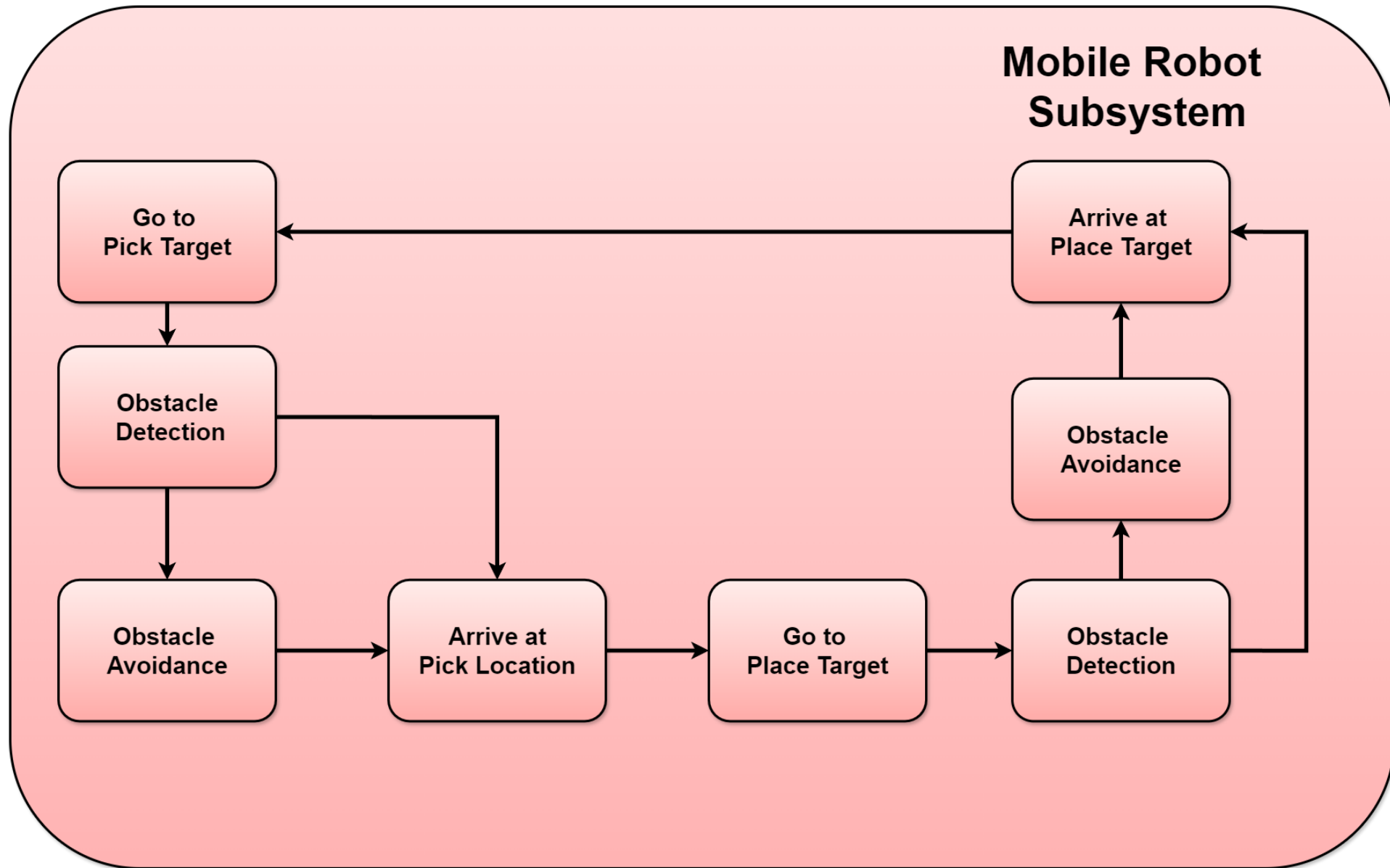




Subsystems Diagram:



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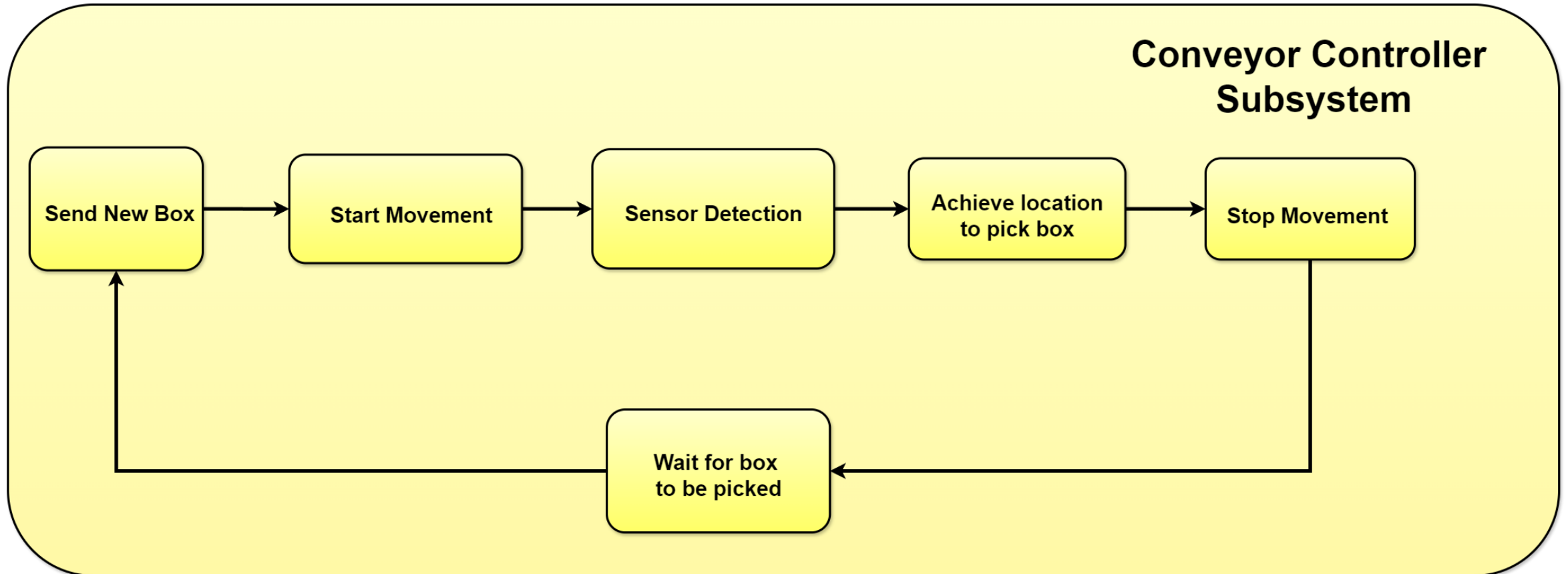




Subsystems Diagram:



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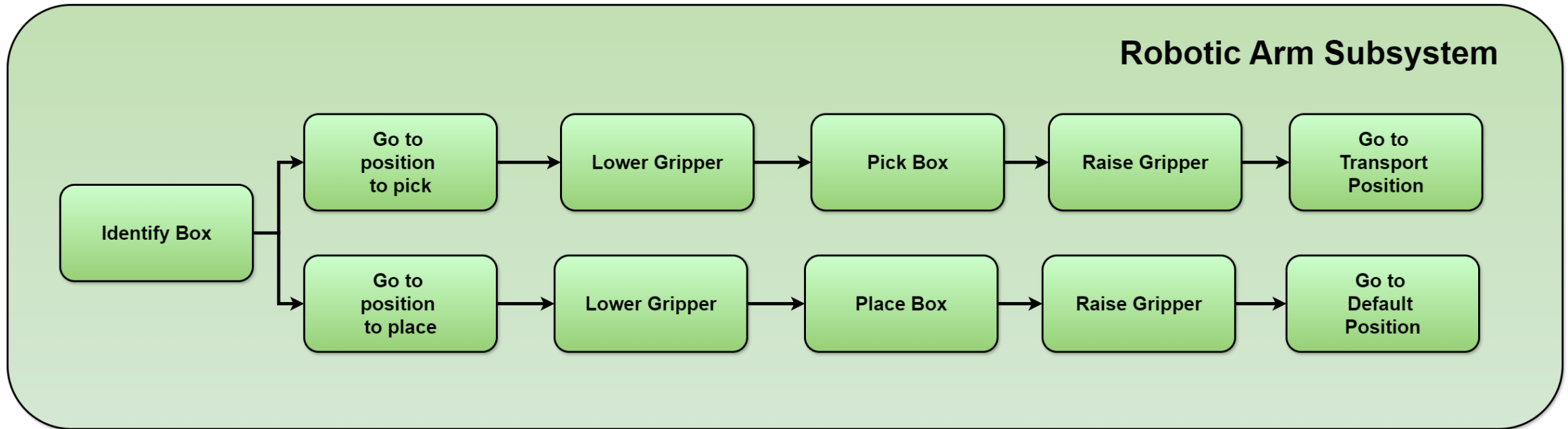




Subsystems Diagram:



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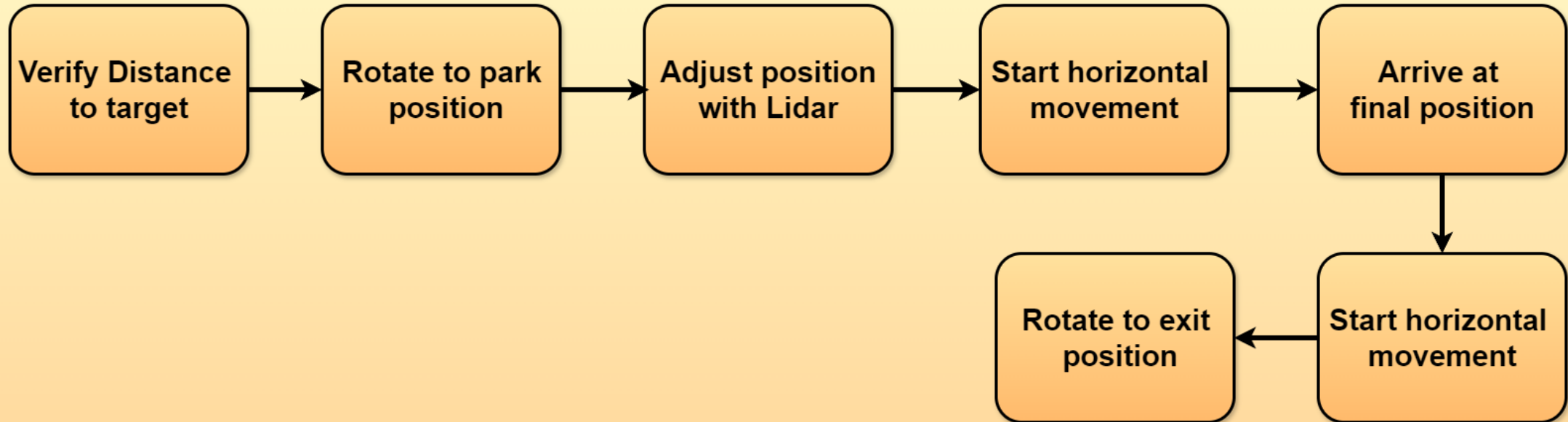


Parking Algorithm:



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Parking Subsystem





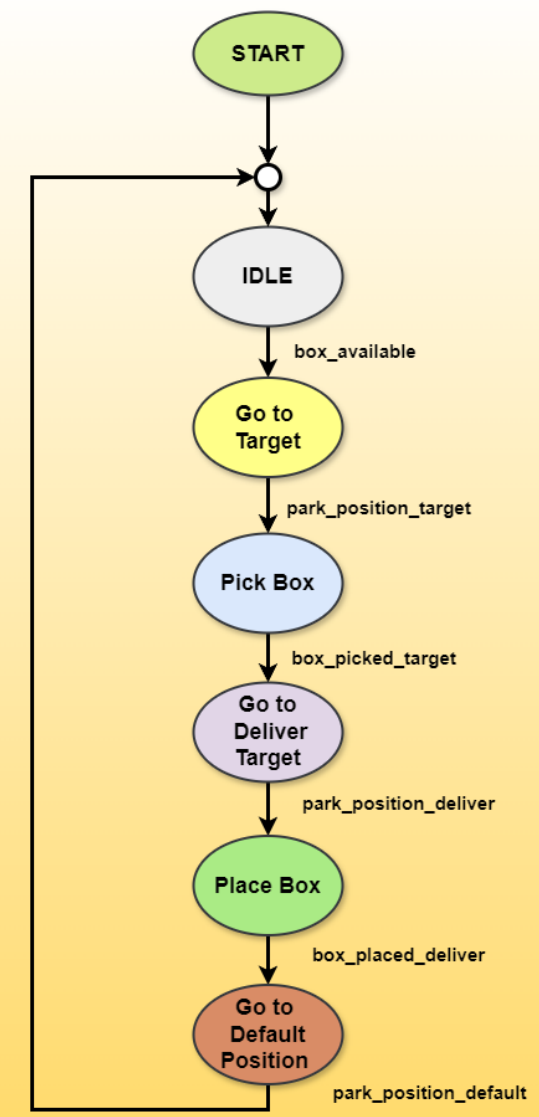
State Machine (Simplified):



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State Machine Simplified

Subtitle	
box_available	- Check if there is a box to be picked
park_position_target	- Verify if robot is in the position to pick the target
box_picked_target	- Check if Robot picked the target
park_position_deliver	- Verify if robot is in the position to deliver target
box_placed_deliver	- Check if Robot delivered the target
park_position_default	- Verify if Robot is in the default position (standby)





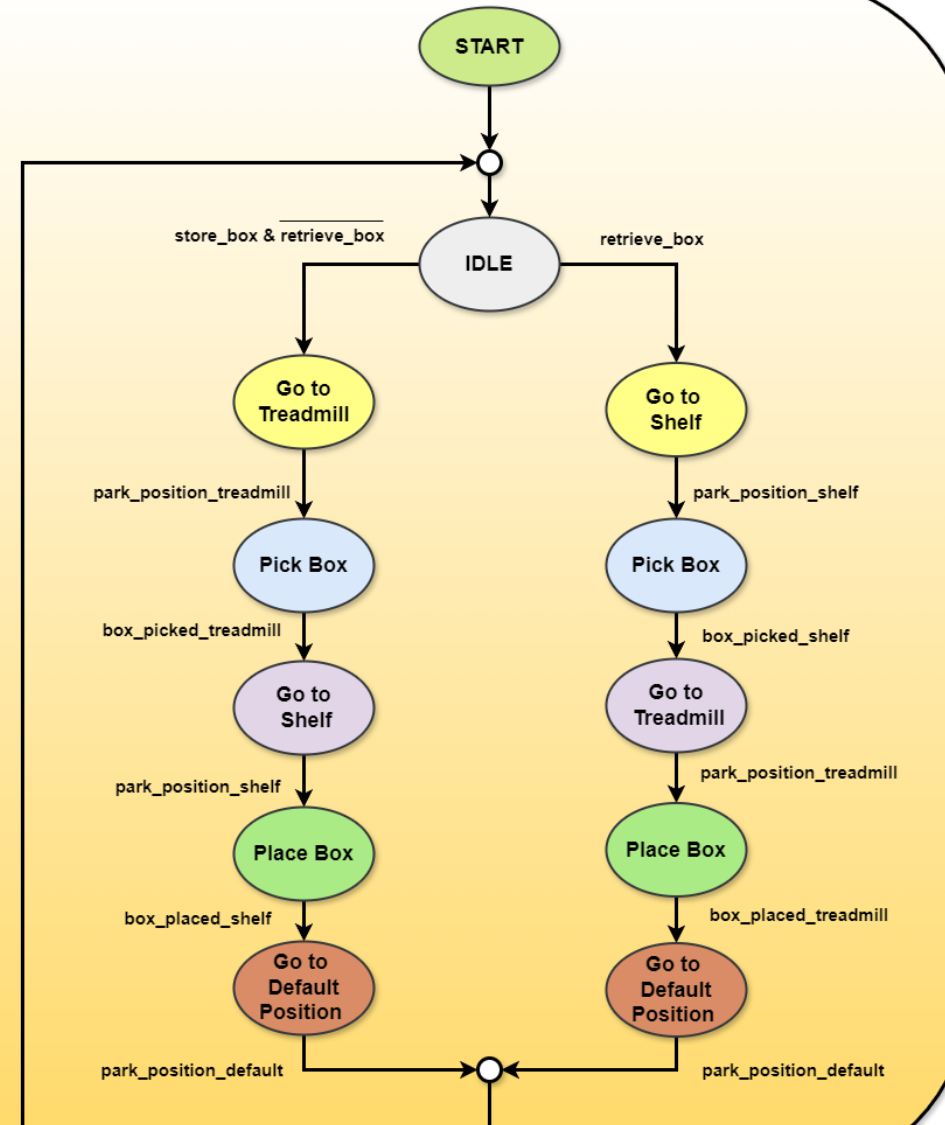
State Machine (Detailed):



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State Machine Detailed

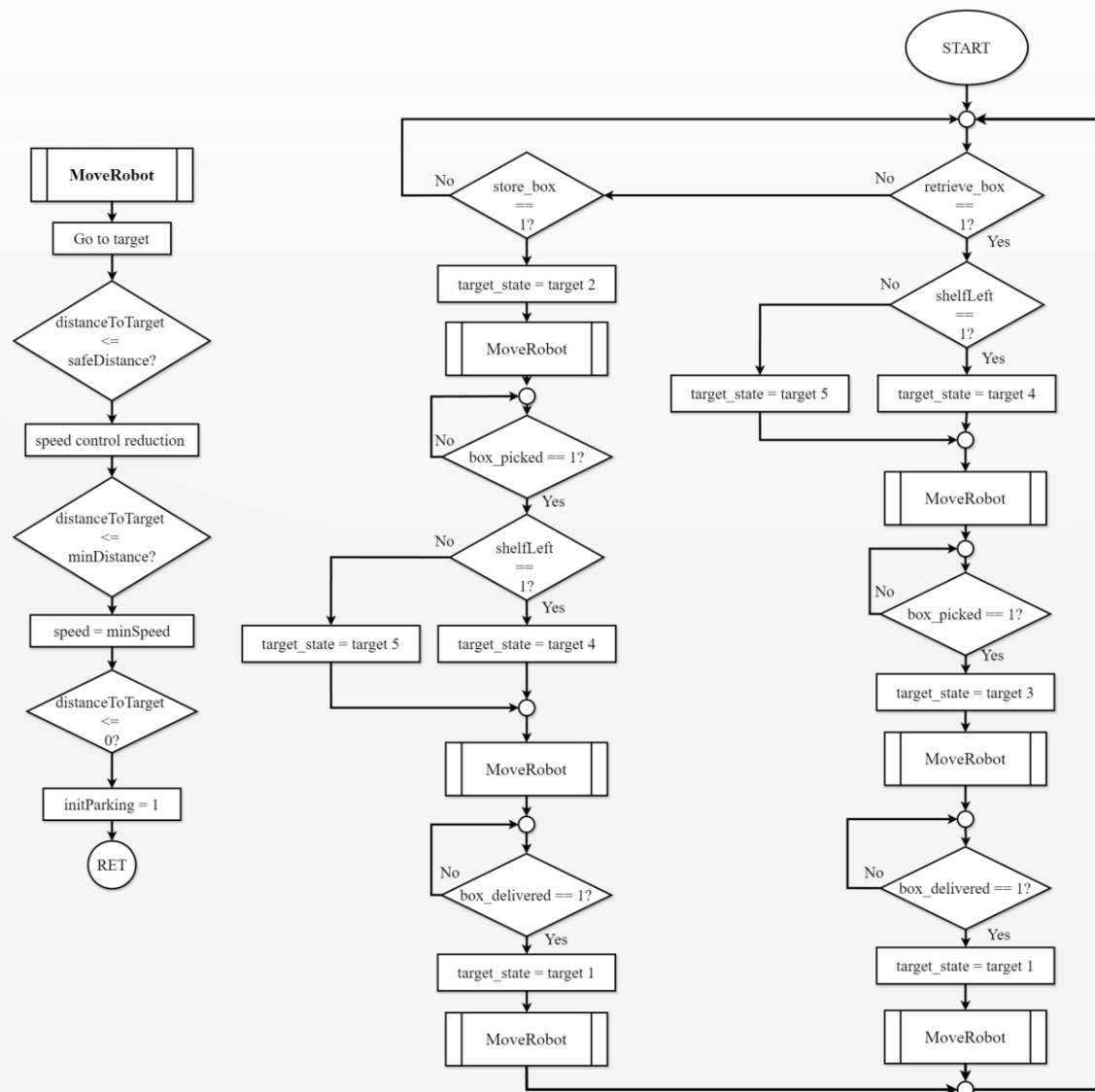
Subtitle	
store_box	- Check if there is a box to be stored in a shelf
retrieve_box	- Check if there is a box to be retrieved from a shelf
park_position_treadmill	- Verify if robot is in the position to pick box from treadmill
park_position_shelf	- Verify if robot is in the position to pick box from shelf
box_picked_treadmill	- Check if Robot picked the box from treadmill
box_picked_shelf	- Check if Robot picked the box from shelf
park_position_shelf	- Verify if robot is in the position to deliver box in the shelf
park_position_treadmill	- Verify if robot is in the position to deliver box in the treadmill
box_placed_shelf	- Check if Robot delivered the box in the shelf
box_placed_treadmill	- Check if Robot delivered the box in the treadmill
park_position_default	- Verify if Robot is in the default position (standby)





Mobile Robot Fluxogram:

Mobile Robot Fluxogram



target 1 - Default Position
target 2 - conveyorIn
target 3 - conveyorOut
target 4 - ShelfLeft
target 5 - ShelfRight



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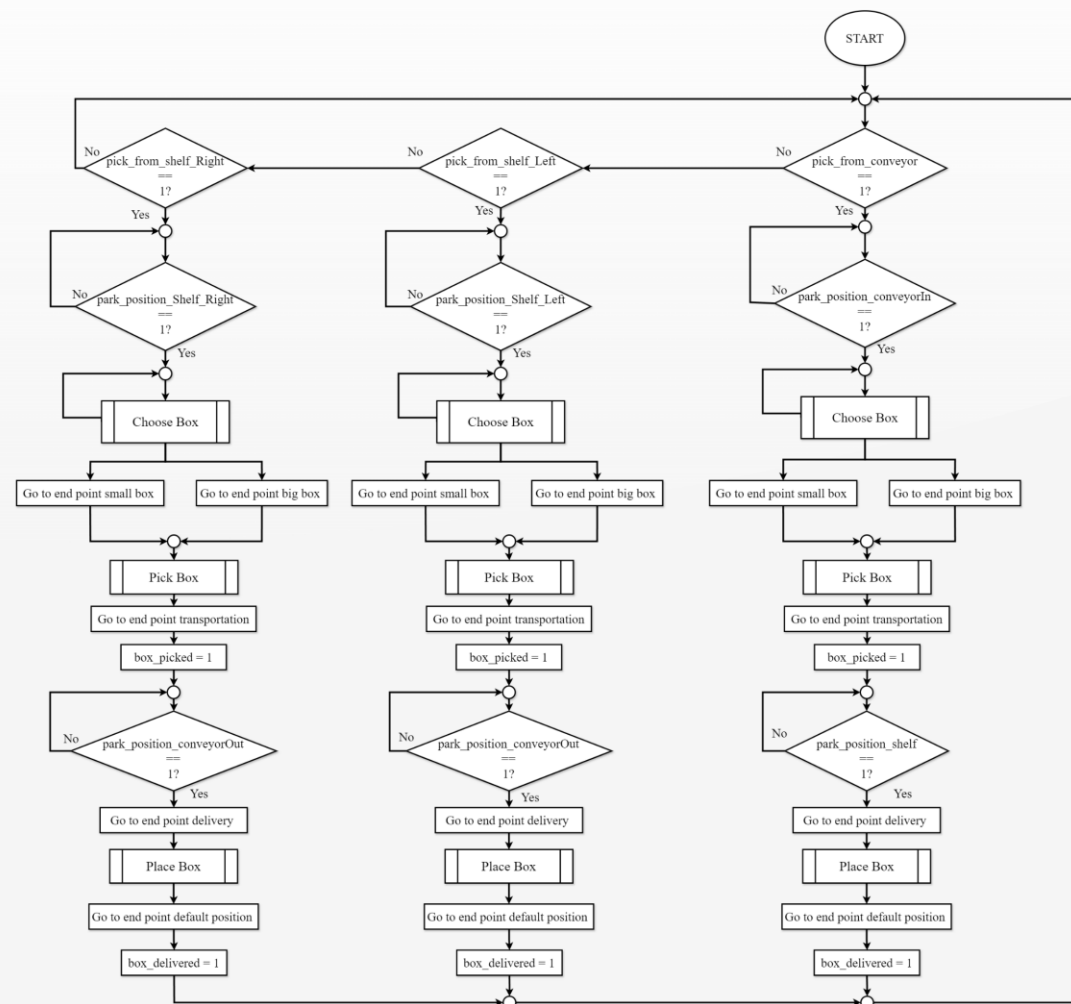
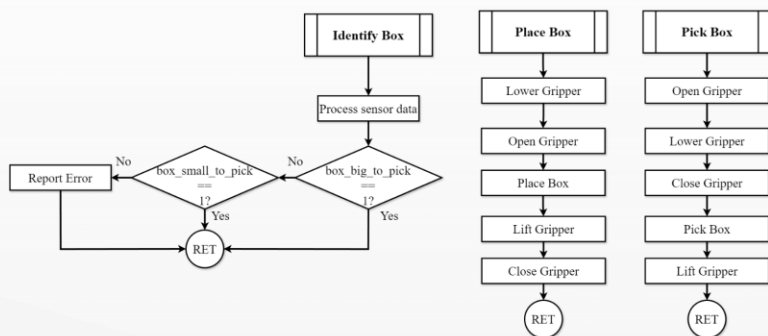


Robotic Arm Fluxogram:



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Robotic Arm Fluxogram



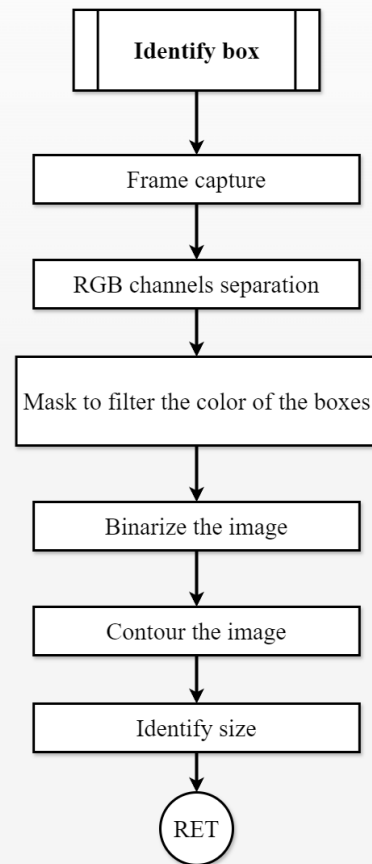


Vision Algorithm Fluxogram:



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Vision Fluxogram





Vision Algorithm Test:

Original Image

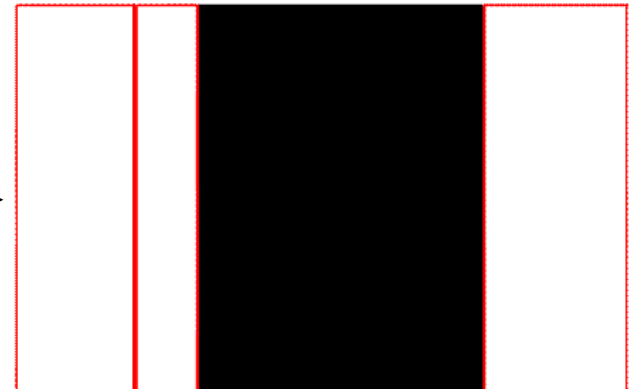


Image without black color

Binary Image

Image with contours



Conveyor Communication Test:



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The screenshot displays the CoppeliaSim software interface, which is used for simulating robotic systems. The interface is divided into several panels:

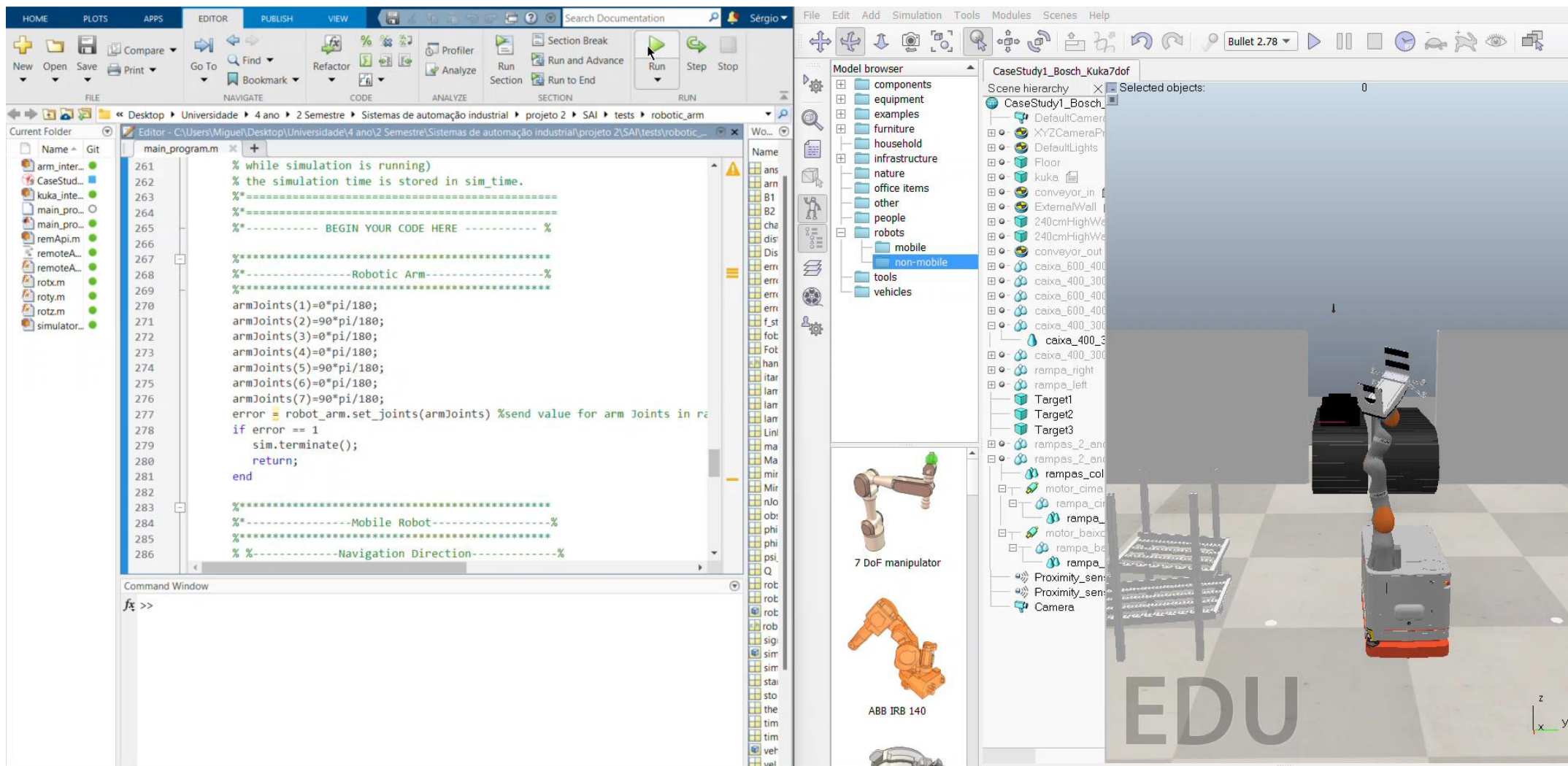
- Top Panel:** Contains tabs for HOME, PLOTS, APPS, EDITOR, PUBLISH, and VIEW. Below these are various toolbars for file operations, navigation, code editing, and simulation control.
- Left Panel:** Shows the 'Current Folder' tree, listing files like CaseStudy1, kuka_inter..., main_pro..., remApi.m, remoteAp..., rotx.m, roty.m, and rotz.m.
- Center Panel:** Displays the Lua script 'main_program.m'. The script contains logic for controlling a conveyor belt, including functions for moving, stopping, and starting the belt based on target distances and delays. The script ends with a comment: '%*----- END OF YOUR CODE -----%*'. Below the script is a 'Command Window' with a prompt 'fx >>'.
- Right Panel:** Features a 'Model browser' showing a hierarchy of objects in the scene, including components, equipment, examples, furniture, household, infrastructure, nature, office items, other, people, robots, mobile, non-mobile, and vehicles. Below this is a 'Scene hierarchy' tree showing the structure of the simulation, including objects like DefaultCamera, XYZCamera, DefaultLights, Floor, kuka, conveyor_in, ExternalWall, 240cmHighWa, conveyor_out, caixa_600_400, caixa_400_300, rampa_right, rampa_left, Target1, Target2, Target3, rampas_2_end, rampas_2_start, rampas_col, motor_cima, rampa_cima, motor_baixo, rampa_baixo, Proximity_sensor, and Camera.
- Bottom Panel:** Shows a 3D view of the simulation environment. It includes a 7 DoF manipulator (labeled '7 DoF manipulator') and an ABB IRB 140 robot arm (labeled 'ABB IRB 140'). A conveyor belt system is visible, with a large 'EDU' watermark overlaid on the scene. A coordinate system (x, y, z) is shown in the bottom right corner.
- Bottom Right Panel:** Displays error messages from the simulation, including a message about a failed external call to 'simCallScriptFunction'.



Robotic Arm Communication Test:



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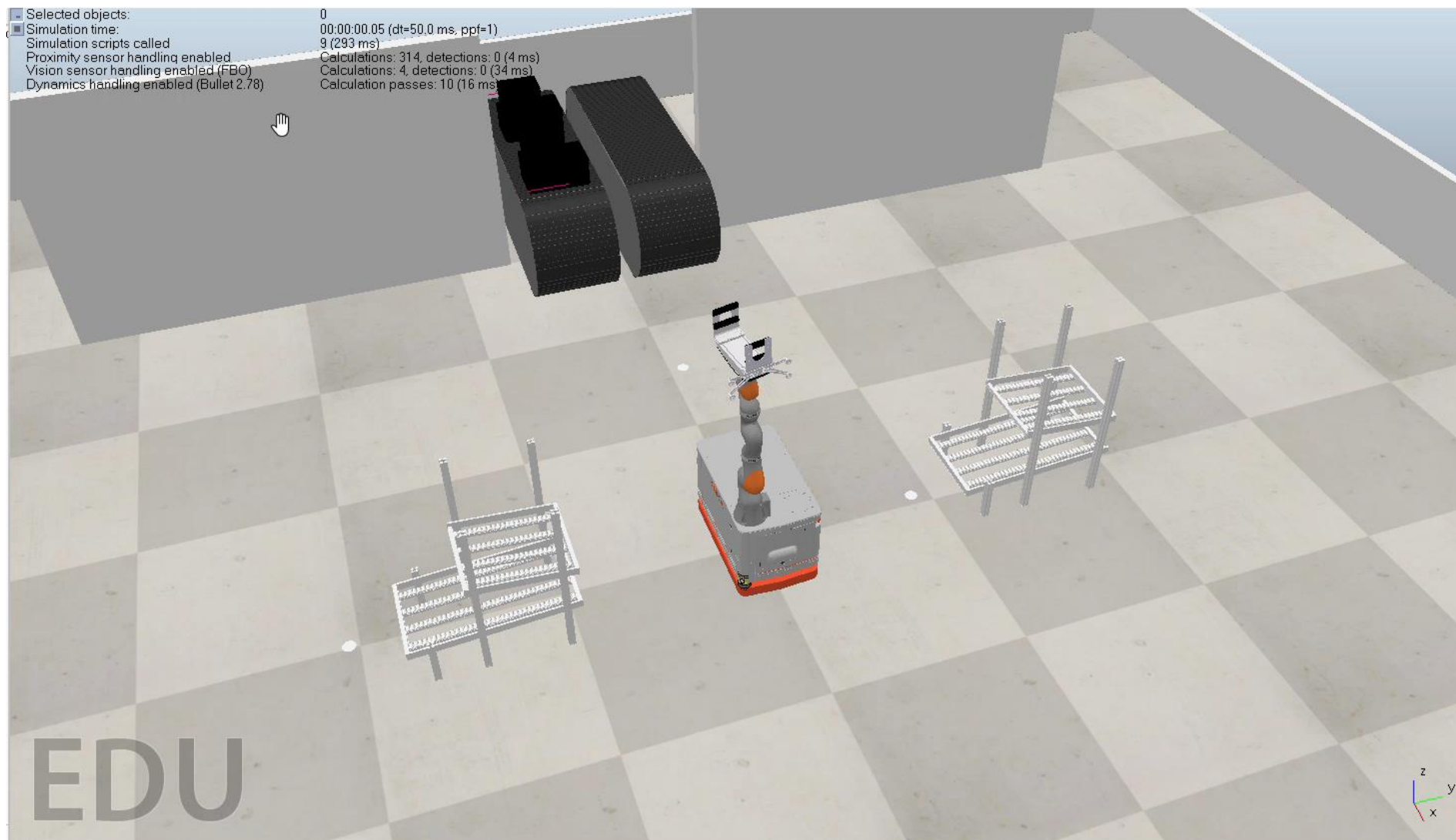




Initial Integration Test:



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Next Steps:



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- **Optimize speed control system;**
- **Conveyor controller implementation;**
- **Optimize Mobile Robot implementation;**
- **Begin parking algorithm implementation;**
- **Implementation of state machine (initial draft);**
- **Design and implementation of the image processing system;**



Thank you!
Any questions?

May the force be with you!

